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SCIENTIFIC BOOKS

The Mechanistic Conception of Life. By Professor JACQUES LOEB. University of Chicago Press. 1912. Pp. 232.

The title and the contents of this volume convey very different impressions to the reader. The title leads one to expect that in the volume one will find a demonstration that vital phenomena are mechanistic, or an exposition of the organism as a mechanism, or some discussion of the points at issue between the mechanist in biology and his opponent, the vitalist. But, on reading the book, this expectation is not realized. Instead one finds, as the preface states, that the volume consists only of "essays—written on different occasions mostly in response to requests for a popular presentation of the results of the author's investigations." Indeed, it is further quite frankly acknowledged, that "the title of the volume characterizes the general tendency of these investigations as an attempt to analyze life from a purely physical-chemical viewpoint." The papers which make up the volume deal primarily and almost exclusively with the following subjects: The Activation of the Egg and Heredity, Tropisms, the Comparative Physiology of the Nervous System, Pattern Adaptation in Fishes, Physiological Morphology, Fertilization, Artificial Parthenogenesis, The Prevention of the Death of the Egg, and the Experimental Study of the Influence of the Environment on Animals.

Of the actual contents so far as they correspond to what is indicated by the statements of the preface a reviewer need make no criticism. Suffice it to say in description of them, that they consist for the most part of the narration and interpretation of various experiments in application of physical chemistry to certain isolated cases of vital phenomena. In the employment of this method Professor Loeb has been, as is well known, a pioneer, and no one can gainsay the importance of his discoveries. They form one of the most dramatic chapters in the history of biology. Indeed one can but recognize the brilliancy of Professor Loeb's hypotheses and

experiments in attacking specific problems, and be grateful for the stimulus which his viewpoint and resulting methods have given to biological research. In general, one can only praise *any* new experimental method which brings results, and one can not repudiate by mere argumentation the facts which such a method reveals. Thus it would be only by repeating Professor Loeb's experiments and finding that they do not give the results which are claimed for them, or by throwing doubt upon them by cognate experiments, that one could put himself in a position justifiably to dispute or criticize the experimental data which are presented in the volume under review. Accordingly, since the greater part of Professor Loeb's book deals with specific methods and results of the kind just indicated, it is left for a reviewer to make only a few comments and general criticisms. However, by way of fulfilling this function, it would seem pertinent to raise the question, especially *à propos* of the title of the book, why Professor Loeb should have selected these particular essays to place under the caption of *The Mechanistic Conception of Life*, when he has so many others that would have served the purpose equally well. Further, it may be remarked concerning the papers selected and now called "Essays," that there is not discoverable, either in their arrangement or in the data which they present, any system which converges to that which both the title and certain emphasized statements of the volume would indicate to be its chief purpose and claim, namely, the demonstration of the applicability, in some specific sense, of the mechanistic conception to *all life and to all that life manifests*. One can make this criticism, and yet admire the brilliancy and fruitfulness of Professor Loeb's experiments. One can indeed thus criticize, and yet be convinced that in *some sense* the mechanistic conception of life is the correct one, and certainly that it is a very fruitful one in stimulating such experiments as Professor Loeb's. But one can hold this conviction, and still find good reasons for maintaining that *such* experiments, consisting for the most part of the application

of physical chemistry to a relatively few vital phenomena, do not prove that *life and all its manifestations* are mechanistic in any but the most general sense of this term, if, indeed, in this way. While a reviewer, then, may not, perhaps, be in a position to take issue with Professor Loeb's specific experiments and results, he may be permitted to make a few comments concerning the method which conceivably might lead to the establishment of Professor Loeb's broad generalizations, or, at least, would clarify them.

It would certainly seem, if one wished to demonstrate that life is, or is not, mechanistic in any exact sense, that one should, for example, state with precision that meaning of this term which is commonly accepted by authorities on mechanics. The term thus defined is, that mechanics is the science of masses moving, and acted upon by forces, in accordance with Newton's laws and the principles of d'Alembert, of Hamilton and of Lagrange. Having thus defined the term either in this or in some other precise way, one could then ascertain whether the organism has such characteristics as warrant putting it in its entirety, or in part, under the conception of mechanism. But Professor Loeb nowhere pursues this method. For his broad generalization, his only real argument, stripped of its rhetorical clothing, is, that, since certain relatively isolated life phenomena can be experimented with by the methods of chemistry, physics and physical chemistry, and accounted for by the results of these sciences, *all life in all of its aspects* is mechanistic. However, it is clear that this conclusion in any precise sense follows, provided only that chemical, physical and chemical-physical phenomena are themselves mechanistic in some precise and technical sense of the term. But, whether they are this or not, and, if they are, to what extent, are themselves questions which are to-day undecided, or, at least, usually not made clear. Vital phenomena do undoubtedly involve chemical and physical processes, but these processes at the present time have themselves not been successfully treated by all the orthodox mech-

anistic principles. At best one finds physico-chemical phenomena treated only from the standpoint of the law of the conservation of energy and the second law of thermodynamics. However, the criticism which on this ground can be made against Professor Loeb is one that is by no means to be directed against him alone, but can be made a very general one. For the only argument that is usually found among biologists for the mechanistic conception is the one which he presents. In fact, with this the case, it must be said, that really all that most biologists mean by "mechanistic" is what Professor Loeb means, namely, that which is physical, chemical and physical-chemical, or, more precisely, simply that which is *determined or caused*. However, *there is a more exact scientific meaning* of the term in accordance with which it may fairly be asked, if physical and chemical phenomena are ever *wholly* and *exclusively* mechanistic. Put with precision, the question is, whether these phenomena are wholly and exclusively moving masses acted on by forces, as defined, described and explained by Newton's laws and the classical principles previously mentioned. Thus stated, the question suggests the broader and more important ones, scientifically and philosophically: Are *all* the things with which we are acquainted in this universe of ours mechanistic in this precise sense, and, if they are, what does this mean? Does it mean that *all* phenomena are *reducible* to masses in motion in the sense that they ultimately consist of nothing but these moving masses, or does it mean only that *all* phenomena are *compatible* with the laws of moving masses acted on by forces, but are nevertheless more than motion and masses, even as, for example, physical objects are numerical, but are more than the positive integers with which they are in one-one correspondence? These two concepts, "reducible to" and "compatible with," are radically different in their implications, and it is difficult to find either the biologist or the physicist who, holding to the universal applicability of the mechanistic conception, makes them clear. However, if one contends that something, say, the organism, is mech-

anistic, and interprets this to mean either "compatible with" (Loeb) or "reducible to" mechanism, then, in order merely to comply with the usual principles of *scientific* procedure, should he not determine with at least some precision the meaning of these terms? Otherwise, does not the claim, that the object under examination is mechanistic, have only the most general and indefinite meaning, such as "determined," etc.? Indeed, is not this meaning the only one that characterizes the position of most biologists, that life and life's phenomena are mechanistic? But is not "determined" itself a very general and indefinite concept, awaiting, for precision, the specification of particular causes?

As concerns method, then, the reviewer is of the opinion that neither the experiments described by Professor Loeb in this volume, nor, in fact, the whole list of results and experiments obtained up to the present time in application of physical chemistry to vital phenomena, scientifically justify the sweeping conclusion, either insinuated or made explicit, that life and all that life manifests in the field of conduct (ethics), science, religion and art, etc., are mechanistic in any precise sense. Such phenomena may be determined and caused. That few would deny. And they *may* also be mechanistic in some more precise and technical sense of the term. But until that sense is defined, and the meanings of such terms as "reducible to," "compatible with," and "explainable by" are specified with precision, so that it can be ascertained whether or not life and life's manifestations are of such specific character as in some one of these ways to be brought under mechanism, proof is lacking for what is otherwise only a vague conviction. However, in the present stage of the analysis of most phenomena manifested by living beings, both human and non-human, there does not seem to be discoverable sufficient evidence to show that they are reducible to, or explainable by mechanistic principles in any other than the most general sense. The successful application of physical chemistry to certain isolated biological phenomena must, of course, be admitted, and the

position that all of life's manifestations may ultimately be also so *related* must be regarded as a perfectly permissible working hypothesis. But at the present time the position that mechanics, physics and chemistry are, or ever will be capable of *explaining*, in any precise sense, the greater part of vital phenomena and of life's manifestation, is so remote from the experimental facts, that it can be regarded as only a pure assumption.

The reviewer can find, then, only a minimum either of justification or of meaning in such claims as Professor Loeb's book purports to make, namely, that *all* human conduct, in morals, esthetics, scientific thinking and religion, is mechanistic. Nor is there any more justification or meaning for the view that it is provided only all such phenomena are mechanistic and can be related to physical chemistry, that there can be a science of them. One might as well claim that, until the brain is completely explained by physical chemistry, there can be no science of mathematics, since the mathematician's thinking is dependent upon his brain. Science is certainly not limited to physics and chemistry and their hybrid, physical chemistry; even where these sciences are not applicable, there may be description and explanation, hypothesis and confirmation, prediction and control, exactness and computation, causation and system.

But further, it may be asked, not as concerns Professor Loeb's methods, but as concerns his broad generalizations, What would they mean even if they were true? What, for example, does it mean to say that ethics, mathematics, literature, law, etc., are mechanistic? Does it mean anything more than that they are *consistent* with mechanistic principles in the technical sense or that the phenomena dealt with in these fields of knowledge are subject to the law of causation? But even with this meaning, would so saying help to understand, or to get at specific results in, the levels of phenomena with which these branches of knowledge are concerned? Would not these branches still continue to exist? And would not the phenomena with which they deal have to be scientifically investigated

at the higher level in order to find something subsequently to be reduced to, or explained by, mechanistic principles if possible? But with *everything* mechanistic in the sense only of being consistent with mechanistic principles, or of being caused, would there not still be something left over which would not be *identical with* mechanism in the precise and technical sense of that term? It is the conviction that there would be—a conviction which can be based on proof—that has actuated the reviewer to write this rather long notice of Professor Loeb's book. Everything that exists is not identical with nor explainable by mechanism in the technical meaning of the term, although it is compatible with it in the sense that one fact can not contradict or exclude the reality of another, and is in some relation with it. And all science is not physics, chemistry and physical chemistry. The tendency of many scientists to maintain the negative of these two propositions is a misleading influence and a stimulus to false hopes, especially when prominence in science lends its weight to the claim. But the tendency is not only a dangerous one; it also represents a bias which is contrary to that broad-mindedness which is held to mark the scientific mind. It is because Professor Loeb's book exemplifies this tendency to so marked a degree, that the opportunity of reviewing the book has been used to enter protest. As a collection of essays in the application of physical chemistry to biology one can only praise the volume. But as a philosophic work, which finds in this application ground for insinuating the universal validity of the mechanistic conception in some precise sense, but really making this only most general, one can only doubt and question. The scientist may justifiably resent the intrusion of the philosopher into science's realm, unless the philosopher becomes scientist. But when the scientist becomes philosopher, as does Professor Loeb, he exposes himself to that broader scientific criticism which is philosophy. The venture may be daring, but does not the daring only seem? For are not "we ourselves only chemical mechanisms"? Then where lieth the blame if some

atoms become philosophers and in the combat some philosophers become atoms?

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The Birds of Africa. By G. E. SHELLEY. Volume V., Part 2. Completed and edited by W. L. SCLATER. London: Henry Sotheman & Co. 1912. Pp. viii + 165-502; pls. L.-LVII.

The publication of Captain G. E. Shelley's elaborate work on the birds of Africa was interrupted in 1906, after the appearance of the first part of the fifth volume, by the serious illness and consequent death of the author. Mr. W. L. Sclater, whose knowledge of the African avifauna well fits him to carry out the original plan, has undertaken to complete the work; and the present instalment is the first to appear under his supervision.

The general treatment of the subject is the same as in previous volumes. Brief diagnoses of superfamily groups, or "sections," are given; also keys to families and subfamilies; with diagnoses of families and keys to genera. Each genus is defined, furnished with proper synonymy, a key to its species, and in most cases with a statement of its geographical range. Under specific headings are given pertinent synonymy; descriptions of the adult plumage of both sexes, and, where possible, of juvenal and nestling; brief measurements, apparently of single birds; a general statement of geographical distribution, and a good account of habits, often two or three pages long, and including mention of many particular localities where the bird has been observed.

Little account is taken of subspecies, when recognized as such, and none are given separate headings. They are treated, if at all, in the text under their respective species, with sometimes a binomial, sometimes a trinomial name. Some are, however, considered as absolute synonyms; while a few are given full specific rank. Of those recognized as subspecies the synonymy is given, and usually, though not always, the diagnostic characters.

The book includes nominally 209 species